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Vector Control During Operation Restore Hope - Somalia

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Introduction

During the early stages of Operation Restore Hope, three U.S. Army preventive medicine detachments were deployed to Somalia to counter the disease and non-battle injury threat to deployed forces. The activities of these units are discussed, with an emphasis on the entomology detachment. The preventive medicine (PVNTMED) threat facing deployed forces was considerable and probably greater than that encountered in any recent operation, including Operations Iraqi Freedom and Enduring Freedom. This threat is discussed, as are the methods used by the PVNTMED detachments to counter the threat. Vector control and pest management operations of the entomology detachment are highlighted, and how they related to the health and comfort of deployed personnel. These operations ranged from routine mosquito surveillance to large-area vector-control missions using a helicopter-slung pesticide dispersal unit. A variety of "lessons learned" are also discussed, focusing on Individual and company-level PVNTMED measures.

United States forces deploying to Somalia during Operation Restore Hope encountered significant disease and environmental health risks. The disease threat was assumed to be greater than that encountered during any recent military operation, including Operation Desert Shield/Storm. Due to the high heat of the dry season, and given that most personnel deployed during the winter months in the U.S., heat-related

injuries were thought to be the most immediate risk to soldiers deploying to Somalia. Food- and waterborne diseases (including acute diarrheal diseases, typhoid and paratyphoid, hepatitis A and E, enteric protozoal diseases, and cholera) also provided significant disease risks, followed by malaria and arboviral fevers. Other health risks were attributable to poor sanitation, indiscriminate disposal of wastes, lack of public health infrastructure, and other concerns such as vehicle accidents and poisonous plants and animals.¹

The initial challenges facing U.S. Army forces were to prepare safe areas for newly arriving forces, obtain safe water supplies, and control potential vector insects. Many of the areas occupied by our forces had been devastated. In industrial areas hazardous chemicals were spilled or left in damaged containers. Potable water was a critical commodity during the early phases of the deployment. Wells and distribution systems had been destroyed by looting and vandalism. Local water supplies were heavily contaminated by bacteria, and the mineral contents generally exceeded U.S. military field water-quality standards for consumptive uses.

During the initial deployment of U.S. Marines, selected U.S. Army forces, and U.S. Navy medical personnel had the vector control/preventive medicine responsibility for deployed forces. As U.S. military involvement increased in early January 1993, three U.S. Army preventive medicine detachments

deployed to Somalia. The "hand-off" of theater responsibility for preventive medicine from the Navy to the Army occurred on approximately February 1, 1993. The 485th Medical Detachment (Entomology) from Fort Polk, Louisiana, the 61st Medical Detachment (Sanitation) from Fort Campbell, Kentucky, and the 224th Medical Detachment (Sanitation) from Fort Hood, Texas, constituted the Army's echelon III and echelon IV (combined) preventive medicine/vector control capability. These detachments each had approximately 11 soldiers and similar preventive medicine (PVNTMED) capabilities. The 62nd Medical Group from Fort Lewis, Washington, provided command and control for all three detachments.

Initially, the mission of U.S. forces was limited to securing the food distribution system for relief organizations (i.e., ports of entry, warehouses, and convoy routes). Humanitarian assistance was to be left to the various international relief organizations

already in country. Therefore the mission of preventive medicine units was to maintain the health of U.S. forces and not to restore the non-functioning public health system of Somalia. The purpose of this presentation is to present information concerning the activities of deployed U.S. Army preventive medicine detachments during Operation Restore Hope, focusing primarily on pest and vector control operations. Much of this presentation was previously published in the *Journal Military Medicine* in 1996.²

Field Preventive Medicine Overview

Throughout history, non-battle losses have played a significant role in the outcome of military operations. Prevention of disease and non-battle injury (DNBI) by reducing the medical threat to deployed forces is the objective of preventive medicine. To counter the DNBI threat, the U.S. Army established levels (echelons) of field preventive medicine responsibilities, ranging from individual preventive medicine measures (PMM) to specialized preventive medicine units. Individual PMM included drinking sufficient volumes of water at frequent intervals, using insect repellents and netting properly, consuming food and water only from approved sources, and taking appropriate chemoprophylaxis.

Company-level PMM included forming, equipping, and training a unit field sanitation team. This team, which comprised a trained non-commissioned officer and soldier, was responsible primarily for conducting individual PMM training, monitoring the status of unit PMM (water disinfection, food service sanitation, latrine construction, etc.), and conducting limited arthropod and rodent control. In essence, this team advised the small-unit commander in all areas of field preventive medicine.

The next level of preventive medicine support (echelon II) was at the division or separate brigade. The preventive medicine section of the medical battalion or main support battalion provided services including identification of the preventive medicine threat and problems, and training of unit field sanitation teams.

At echelons III and IV (combined), additional PVNTMED support was provided by small, mobile PVNTMED detachments. During the early 1990s, there were two types of Army

PVNTMED detachments: the Medical Detachment, Preventive Medicine (Entomology) and the Medical Detachment, Preventive Medicine (Sanitation). The common mission of both detachments was to provide PVNTMED support and consultation in the areas of entomology, DNBI prevention, field sanitation, sanitary engineering, and epidemiology. Both detachments had similar capabilities; however, the entomology detachment had the additional capability of providing area vector control using truck-mounted and helicopter-slung pesticide-dispersal units. The echelons of field preventive medicine in the Army today remain essentially the same, but the Army has transformed the two types of PVNTMED detachments and merged their capabilities into a single unit - the Medical Detachment (Preventive Medicine).

Activities of PVNTMED Detachments

Peak U.S. forces strength in theater reached approximately 20,000 by the end of January 1993. The largest concentration of personnel was in Mogadishu, with various levels of troops in Baidoa and Bardera to the west and in Kismayu in the south. Theater responsibility for PVNTMED was divided among the three detachments, with the exception that the 485th, being the only entomology unit, had theater-wide responsibility for area vector control. During the deployment, PVNTMED detachments spent approximately 80% of their duty time providing general PVNTMED support and 20% on arthropod surveillance and control.

One of the major challenges facing the PVNTMED detachments was that the majority of the Army's company-

sized units had deployed with poorly trained and equipped field sanitation teams (FSTs). For example, out of 17 units evaluated by the 485th Medical Detachment in the early stages of the deployment, only 3 had fully functional FSTs. As the PVNTMED detachments had to undertake various unit FST responsibilities (e.g., training unit personnel, providing FST supplies, conducting unit-level cockroach and rodent control, inspecting unit water supplies), their ability to provide echelon III and IV support was significantly hampered.

Typically, a PVNTMED detachment's daily activities would include sending out a pair of two-vehicle, four-man teams to supported units. The purpose of the visits was to inspect company- or unit-level PMM, which would include inspecting the unit food service facility, waste disposal operations, and chlorine levels in unit water trailers/blivets. Each unit was visited/inspected weekly. In addition, PVNTMED personnel took water samples from water distribution sites and conducted bacteriological and chemical analyses. They also routinely tested samples of bottled water coming into the theater.

Vector Control/Pest Management Operations

The threat to deployed forces in Somalia from arthropod-borne and other animal-associated diseases was significant. Mosquito-borne diseases, such as malaria and dengue, accounted for a large number of cases of arthropod-borne illnesses.^{2,3} However, endemic illnesses transmitted by or associated with filth flies, sand flies, ticks, fleas, and domestic animals also were potential threats.

Given the lack of current or reliable vector and epidemiological data on Somalia, it was important for the PVNTMED detachments to determine which vector species were present. This was not an easy task, because accurate and usable arthropod Identification materials (i.e., keys) were nonexistent. Additionally, no field rapid diagnostic tests or assays had been developed, or none were available to the detachments during the deployment to determine whether collected arthropods were infected with disease-causing organisms.

Mosquito-Borne Diseases

Malaria (*Plasmodium falciparum* and *P. vivax*), transmitted by *Anopheles gambiae* sensu lato and *A. junestus* mosquitoes, was the most important vector-borne disease faced by deployed forces. From December 1992 to September 1993, 48 cases of malaria were diagnosed among U.S. personnel in country. The majority of these cases were from personnel stationed in the southern riverine areas of Bardera and Jilib. Subsequently, 79 malaria cases were described in U.S. Army soldiers returning to Fort Drum, and another 112 cases were reported from U.S. Marines returning from Somalia.^{4,5}

Dengue, transmitted primarily by *Aedes aegypti* mosquitoes, was also present and diagnosed in many cases in which an identified etiology of fever was not present. Forty-one cases of dengue were diagnosed in U.S. personnel in Somalia during 1992-1993.³ A variety of arboviruses and filarial parasites are also known to occur in Somalia; however, only one case of Sindbis and two cases of West Nile fever, both viral diseases, were confirmed among deployed U.S. forces.⁴

There are many mosquito surveillance techniques described in the literature; however, under the constraints of deployment in the austere environment of Operation Restore Hope, options were limited. Both adult and larval mosquito surveys were conducted, but only in areas that were relatively secure tactically, and where mosquito control measures could be employed. Solid-State Army Miniature mosquito light traps were the primary means used to collect adult mosquitoes. Even though these light traps are questionably effective in collecting anophelines, they were the only practical means of adult mosquito surveillance available. These traps were the sole adult mosquito surveillance items included in the authorized equipment of PVNTMED detachments. Depending on the numbers of mosquitoes collected, light traps were usually employed once a week at selected sites.

By the time the Army assumed the PVNTMED responsibilities from the Navy in early February, the apparent number of mosquitoes biting troops in most areas, excluding the southern riverine areas, was reduced. This was due primarily to the dry season and was reflected in the low numbers of adults collected during surveillance activities.

Personal protective measures used against mosquitoes included activities such as applying skin repellent (diethyltoluamide), treating uniforms with permethrin, and sleeping under bed nets. Command emphasis on these measures was very good overall. However, one U.S. Marine infantry battalion suffered a serious outbreak of vector-borne illness due to a lack of attention to these measures. The battalion was deployed in the town of Bardera, along the Jubba River. In the

southern region of Somalia. The unit arrived around the last week of December, and by the end of January more than 60 marines (approximately 8% of the battalion strength) had developed febrile illness and the majority of these had been medically evacuated. As of January 25, the Joint Forward Laboratory in Mogadishu had confirmed 16 cases of malaria and 22 cases of dengue. An additional 19 cases were also believed to be dengue fever.

An investigation of the outbreak and questioning of the patients revealed that mosquito discipline was generally poor. Approximately 40% of the sick marines admitted that they never used skin repellent, and only 20% always used it. Additionally, very few marines used bed nets while sleeping, especially while bivouacked in the town close to the river.

As a result of the vector-borne disease outbreak at Bardera, the Marine Forces Surgeon requested mosquito control assistance from the Army Entomology Detachment. Two aerial pesticide spray missions were conducted by the 485th Medical Detachment in Bardera during the first and last weeks of February. These missions were the first time the Army's new Pesticide Dispersal Unit-Helicopter Slung (PDU) was used in a contingency operation.

Aviation support for the missions was provided by the 159th Air Ambulance Company in the form of UH-60 MEDEVAC helicopters. Applying pesticides is doctrinally not a correct mission for MEDEVAC assets; however, the commander of the Marine's aviation assets on-site at Bardera refused to fly the mission due to his unfamiliarity with the equipment. The Army MEDEVAC flight crews also had no experience with the PDU, but given

the need for the mission they were willing to work with the entomologists and PVNTMED technicians and train with the equipment.

Coordination with the local population before the missions was carried out by an Army Civil Military Operations Team and an Army Special Forces PSYOPS Team, which announced our intentions over loudspeakers, from the ground and air, immediately before each mission. Due to mission constraints and the problems associated with collecting adult mosquitoes described above, there were no statistically significant mosquito collection data to support the claim that the aerial spray missions were successful. However, these missions were deemed successful for two reasons: (1) given the way the missions were conducted and the environmental conditions at the time, adult mosquito mortality of some degree was certainly achieved; and (2) the morale of the soldiers and marines in the vicinity was noticeably improved after each mission. Additionally, given the visibility and apparent priority allotted the missions, the general awareness of the mosquito/arthropod threat was increased, and probably the use of personal protective measures (repellents, bed nets, etc.) was as well. Another aerial spray mission was conducted in Jilib, also in the southern riverine area of the country, and was equally successful.

Truck-mounted aerosol-generated ultra-low-volume equipment (AGULVE) pesticide dispersal units were used for more routine area mosquito control missions. Most of these missions took place at troop concentration sites in Mogadishu. Given that it was the dry season, these control operations were

normally needed only once each week in most areas.

Filth Flies

Somalia is highly endemic for *Escherichia coli* diarrheas, various enteric viruses, typhoid and paratyphoid fevers, salmonellosis, shigellosis, giardiasis, and helminthiasis.^{6,7} Epidemics frequently occur as a result of the extremely poor sanitation conditions. The fecal-oral route is the normal mode of transmission for these illnesses, and house flies and other filth flies have been implicated in amplifying outbreaks.

Overall, theater diarrheal rates remained extremely low, usually below 1% per week.⁸ This low rate, significantly lower than that experienced during Operation Desert Shield/Storm, was directly attributable to the fact that U.S. forces had complete control of all food and water. Additionally, all units in general practiced excellent field sanitation, including screening latrines and using handwashing stations. A few *Shigella* cases were diagnosed, but investigations revealed that no common source or person-to-person transmission occurred. As a result, flies were believed to be responsible for the transmission.

Practicing good sanitation and using fly bait with the pesticide methomyl were successful in controlling filth flies. Small amounts of the bait would be placed adjacent to but away from troop areas, attracting flies that would feed on the bait and rapidly die. Filth fly control was monitored during the weekly PVNTMED inspections of each cantonment area. A more interesting problem was caused by a different type of fly, the "tumbu fly" (*Cordylobia anthropophaga*). This fly is known to cause myiasis, which is an invasion of

the body by fly larvae. Of the thousands of troops deployed to Somalia, only five U.S. personnel were diagnosed with tumbu myiasis. However, once knowledge about this fly became widespread, no animal - insect, reptile, or mammal - seemed to raise as much excitement and concern.

Sand Fly-Borne Diseases

Visceral leishmaniasis occurs in isolated areas of focal endemicity in Somalia, and a variety of sand flies have been incriminated as vectors. Surveillance for sand flies was conducted by PVNTMED personnel in a manner similar to that employed for mosquitoes. Light traps were used, along with castor oil-coated papers (sticky traps) placed in the openings of termite mounds and animal burrows. From January through March, sand fly numbers were usually very low. However, in Afgooye, about 30 km north of Mogadishu, large numbers of sand flies were collected. This area was previously a botanical garden and was occupied by a U.S. Army military police company. The area was surrounded by a high wall and was adjacent to a river. As such, it was an ideal breeding site for sand flies.

The AGULVE truck-mounted sprayers were used to control the sand flies at this site as well as the mosquitoes. The pesticide used for mosquito control (malathion - ULV) was also effective against sand flies.

Other Arthropod Pests

Cockroaches, centipedes, bees, and wasps were the other arthropods most encountered by U.S. personnel and for which PVNTMED detachments received requests for control. Cockroaches, even though not directly associated with

disease transmission, are known to carry a wide variety of pathogenic organisms and seemed to thrive everywhere.

Centipedes ranging in length from 10 to 20 cm were also very common in many areas where U. S. personnel were bivouacked. Centipedes feed mainly on insects, killing their prey by means of poison claws or pincers. Most centipedes are nocturnal and they like to hide during the day in dark places, such as inside boots or under items on the floor or ground. As a result, many unwary soldiers were bitten by not watching where they put their hands and feet. The good news was that the centipedes most often encountered were not highly venomous - the pain resulting from these bites was similar to that of a bee sting for most people.

Control of cockroaches and centipedes, along with other ground-crawling arthropods such as spiders, was accomplished using the pesticide chIorpyrifos (Dursban) applied with 2-gallon hand-held sprayers. These sprayers could be stocked, along with the pesticide, by Army company-sized units for their FSTs as previously discussed. Since so few units had these items, however, the PVNTMED detachments had to provide this service as well. For units fortunate enough to be bivouacked under cover with concrete floors, one treatment with Dursban would last about 3 weeks.

Honey bees also occasionally caused problems around troop areas. The variety of honey bee found in Somalia tends to be more aggressive than the domestic varieties found in the U.S. The venom is no more toxic than that in U.S. species, but the bees tend to sting more readily and in greater numbers. Most of the requests for assistance came when a

colony or hive of bees was found near troop living/working areas.

The same pesticide used for cockroach control was also used to control bees. A hydraulic sprayer, with its pressure-spray capability, was used in many cases to reach areas inaccessible to a 2-gallon sprayer. This sprayer is operated from the back of a truck and during the 1990s was found only in the Entomology Detachment.

Rats

Commensal rats are usually present wherever humans are found, and Somalia was no exception. The characteristics of a disaster area - poor sanitation, temporary shelters, garbage/waste accumulation - all made for an abundant rat population. For example, many of the buildings at the Mogadishu University complex were so heavily infested with rats that when U.S. forces began occupying the buildings it was common for one to look down the cracks between any of the walls and see a few pairs of eyes looking back. Upon awakening in the mornings, soldiers would frequently see rat droppings around their cots.

Rats are responsible for spreading a number of diseases, either directly by contamination of human food with their urine or feces, or indirectly by diseases transmitted by rodent fleas and mites (rat-bite fever, leptospirosis, murine typhus, and plague).

The PVNTMED detachments put out large numbers of poison bait boxes, snap traps, and live traps to control the rats cohabitating with our soldiers. Traps, poison bait, and instructions for constructing bait boxes were also distributed to various units in most compounds. These materials should also

have been stocked by each company-sized unit for their FSTs.

Domestic Animals

Stray cats and especially dogs were also a common site around troop concentration areas. As rabies is endemic to Somalia, in addition to many tick- and flea-borne diseases, these animals presented a significant health risk.

Even when constantly warned to have no contact with animals, soldiers will invariably provide food, water, and attention to stray dogs and cats. This behavior encourages strays to remain in the area, and soon the animal numbers rise, increasing the chance of someone getting bitten or scratched. When stray dogs became habituated to an American compound, and efforts to entice them away were unsuccessful, stronger measures were taken. This usually meant shooting the animals and removing the carcasses.

Goats were also frequently found wandering around inside our compounds. In addition to being infested with the same types of ticks and fleas found on dogs, Q-fever and anthrax are also potential byproducts of cohabitating with these animals. Efforts to rope these animals and remove them from the area were usually successful.

Conclusion

The success of the PVNTMED effort during Operation Restore Hope is difficult to quantify. Given the infectious diseases and environmental health risks in Somalia, the disease threat to U.S. forces was probably greater than that encountered in any recent operation. Fortunately, this was recognized by medical planners prior to the deployment and plans were made

accordingly. During the initial phase of the operation, the Navy provided the PVNTMED support to deployed forces. By the end of January, the Air Force component was in theater, along with three Army PVNTMED detachments. Based on the number of deployed forces, this body of PVNTMED professionals was doctrinally more than three times what was required. Additionally, the Department of Defense medical intelligence community provided some excellent information for field forces in the form of booklets and guides. A guide that was especially valuable for the soldiers “on the ground” was distributed by the U.S. Army Medical Research and Development Command: “Sustaining Soldier Health and Performance in Somalia: Guidance For Small Unit Leaders.” Information in this format has been used successfully in many similar deployments since, including current operations in Iraq and Afghanistan.

The lack of field rapid diagnostics available to the PVNTMED detachments significantly hampered their ability to accurately assess the vector-borne disease threat facing deployed forces. Field assays enable PVNTMED personnel to determine what arthropod species are actually infected with disease-causing organisms, and allow the limited vector control assets to pinpoint the source of the threat.

A valuable lesson learned by deployed Army units is how important the unit field sanitation team can be to the unit, not only by preventing disease but by doing things and providing materials to make the troops more comfortable. Given the current trend of humanitarian assistance and disaster relief operations, field preventive

medicine is becoming increasingly important.

Overall, command emphasis and personal attention to preventive medicine measures such as drinking sufficient water, utilizing insect repellents, and consuming food and water only from approved sources was excellent. Unfortunately, some commanders failed to support PVNTMED and their units suffered as a result, despite the large PVNTMED presence in theater. Preventive medicine support, at any level, in the absence of command emphasis will fail.

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